

TITLE OF THE INVENTION

DSL COMMUNICATION METHOD OF PERFORMING AN  
INTERRUPTION AND A RECONNECTION WHEN AN S/N RATIO IS  
OUTSIDE OF A PREDETERMINED RANGE FOR A DURATION  
5 LONGER THAN A REFERENCE TIME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to  
10 a DSL communication method and a DSL communication  
device and, more particularly, to a DSL  
communication method which interconnects a user and  
a center by using a 2-wire telephone line and a DSL  
(Digital Subscriber Lines) communications technology  
15 so that the user and the center intercommunicate,  
and to a DSL communication device adopting the DSL  
communication method.

2. Description of the Related Art

In an intercommunication according to an  
20 xDSL communications technology, such as HDSL (High-  
bit-rate DSL), SDSL (Symmetric DSL), ADSL  
(Asymmetric DSL), and VDSL (Very-high-bit-rate DSL)  
using a 2-wire telephone line, it is difficult to  
maintain a constant communication quality because a  
25 line quality fluctuates due to mutual interferences  
with a conventionally existing communications  
technology (telephone, an analog modem communication,  
an ISDN, etc.) in a frequency band.

Thereupon, for the purpose of adapting to  
30 circumstances where a constant communication quality  
cannot be maintained, the ITU-T recommendations  
"G.992.1 (G.dmt): Appendix 2" and "G.997.1  
(G.ploam)", which are international standards,  
propose concepts of a method for maintaining an  
35 optimal communication quality under constantly  
changing circumstances by providing a countermeasure  
named "Dynamic Rate Adaptation" realizable during an

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online intercommunication against line quality fluctuations.

However, the above-mentioned method requires supports from intercommunicating DSL devices, such as a negotiation between intercommunicating DSL devices, or an exchange of line quality information therebetween. The method functions only when these method supports are in synchronization. Further, the method can be said to be an optional function.

As described above, an intercommunication according to an xDSL communications technology is performed with a constantly fluctuating line quality, which requires an addition of an optional function for maintaining an optimal communication quality under such circumstances. This addition makes DSL devices functionally complicated, and increases apparatus costs. Also, this addition necessitates integrated functions in operating a system including those DSL devices. This raises a problem in interconnecting DSL devices of different vendors at user/center sides.

#### SUMMARY OF THE INVENTION

It is a general object of the present invention to provide an improved and useful DSL communication method and a DSL communication device in which the above-mentioned problems are eliminated.

A more specific object of the present invention is to provide a DSL communication method which can be adopted in either of intercommunicating devices as an independent function for maintaining an optimal communication quality and communication speed without necessitating an exchange of line quality information between the intercommunicating devices to establish a connection therebetween, and a DSL communication device adopting the DSL

communication method.

In order to achieve the above-mentioned objects, there is provided according to one aspect of the present invention a DSL communication method  
5 for interconnecting a user and a center by using a 2-wire telephone line and a DSL communications technology so that the user and the center perform an intercommunication, the method comprising the steps of:

10 monitoring a signal-to-noise ratio of an accepted DSL;

judging whether or not the signal-to-noise ratio is within a predetermined range; and

interrupting the intercommunication once  
15 and thereafter reconnecting the user and the center, when the signal-to-noise ratio is judged not to be within the predetermined range for a duration longer than a reference time.

The DSL communication method according to  
20 the present invention can maintain an optimal communication quality and communication speed, by utilizing a handshake and initialization function performed by a DSL-interface containing unit of a DSL communication device when establishing a  
25 connection with another DSL communication device on the other end of the line. Additionally, the DSL communication method does not necessitate an exchange of line quality information with the DSL communication device on the other end of the line  
30 when establishing a connection therebetween. Further, the DSL communication method can be adopted in either of the intercommunicating DSL communication devices as an independent function. Therefore, the DSL communication method can be  
35 realized at low costs.

Additionally, the DSL communication method according to the present invention further comprises

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the step of arbitrarily setting an upper limit and a lower limit defining the predetermine range.

According to the present invention, an operator can arbitrarily set the upper limit and the lower limit according to a required communication quality and communication speed.

Additionally, the DSL communication method according to the present invention further comprises the reference time setting step of arbitrarily setting the reference time.

According to the present invention, an operator can arbitrarily set the reference time according to a desired communication quality and communication speed.

Additionally, in the DSL communication method according to the present invention, the reference time setting step sets a first reference time to be compared with a duration during which the signal-to-noise ratio is higher than the upper limit, and sets a second reference time to be compared with a duration during which the signal-to-noise ratio is lower than the lower limit, the first reference time being different from the second reference time.

The DSL communication method according to the present invention can provide a time hysteresis.

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a block diagram of an embodiment of a DSL communication system adopting a DSL communication method according to the present invention;

FIG.2 is a block diagram of an embodiment of a DSL communication device shown in FIG.1 at a

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center/user side;

FIG.3 is a first schematic diagram of operations of a line-quality monitoring function of the DSL communication device according to the present invention; and

FIG.4 is a second schematic diagram of the operations of the line-quality monitoring function of the DSL communication device according to the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will now be given, with reference to the drawings, of embodiments according to the present invention.

FIG.1 is a block diagram of an embodiment of a DSL communication system adopting a DSL communication method according to the present invention. In FIG.1, a DSL communication device 10 at a center side and at least one DSL communication device 12 at a user side are interconnected via a 2-wire telephone line 14 so as to communicate with each other by using an xDSL communications technology.

FIG.2 is a block diagram of an embodiment of the DSL communication device 10/12 at the center/user side. Whereas the DSL communication device 10 at the center side is formed by one circuit shown in FIG.2, the DSL communication device(s) 12 at the user side may be formed by a plurality of the circuits each shown in FIG.2. In FIG.2, a DSL-interface containing unit 20 is connected to the 2-wire telephone line 14 so as to perform an analog transmission with the DSL-interface containing unit 20 (not shown in FIG.2) on the other end of the 2-wire telephone line 14 by using the xDSL communications technology.

The DSL-interface containing unit 20

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contains a DSL communication interface having not only a handshake and initialization function for performing a negotiation over a communication mode and a communication speed, but also a showtime  
5 function for performing an intercommunication after the establishment of the negotiation. Upon the start of a communication, the DSL-interface containing unit 20 performs a negotiation over a communication mode and a communication speed so as  
10 to maintain a signal-to-noise ratio of an accepted DSL in the proximity of a predetermined criterion value (e.g., 6 dB).

A line-quality monitoring unit 22 monitors the signal-to-noise ratio (SNR: S/N ratio)  
15 representing a communication quality of the DSL from which the DSL-interface containing unit 20 is currently receiving data, and supplies the signal-to-noise ratio to an SNR comparing unit (a line-quality judging unit) 24.

20 A target SNR setting unit (a range setting unit) 26 sets an upper limit and a lower limit of a signal-to-noise ratio to be targeted in an intercommunication, and supplies the upper limit and the lower limit to the SNR comparing unit 24. The  
25 upper limit and the lower limit are preset to default values, and can also be set arbitrarily by an operator 32. The upper limit (e.g., 9 dB) is higher than the criterion value (e.g., 6 dB) of the signal-to-noise ratio, and the lower limit (e.g., 3  
30 dB) is lower than the criterion value (e.g., 6 dB).

The SNR comparing unit 24 compares the current signal-to-noise ratio monitored by the line-quality monitoring unit 22 with the upper limit and the lower limit set by the target SNR setting unit  
35 26, and supplies a result of the comparison to a duration monitoring unit 30.

A duration reference time setting unit 28

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sets a reference time (e.g., several tens of seconds to several minutes) to which a hereinbelow-described duration is compared, and supplies the reference time to the duration monitoring unit 30. The

- 5 reference time is preset to a default value, and can also be set arbitrarily by the operator 32.

On the basis of the comparison result supplied from the SNR comparing unit 24, the duration monitoring unit 30 monitors a duration  
10 during which the current signal-to-noise ratio is higher than the upper limit, or is lower than the lower limit. When the duration surpasses the reference time, the duration monitoring unit 30 supplies a result of the monitoring to a  
15 communications controlling unit 34.

When the monitoring result supplied from the duration monitoring unit 30 indicates that the above-mentioned duration surpasses the reference time, the communications controlling unit 34  
20 performs a control of a communication quality improvement with respect to the DSL-interface containing unit 20. Under this control, the DSL-interface containing unit 20 interrupts the current communication once, and thereafter, the DSL-  
25 interface containing unit 20 reconnects to the DSL-interface containing unit 20 on the other end of the 2-wire telephone line 14, and performs a handshake and an initialization so as to establish a  
negotiation for performing an intercommunication  
30 with the DSL-interface-containing-unit-20 on the other end of the 2-wire telephone line 14.

In the course of the above-mentioned interruption to the reconnection, the DSL-interface containing unit 20 performs a negotiation over a  
35 communication mode and a communication speed so as to maintain the signal-to-noise ratio of the accepted DSL in the proximity of the predetermined

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criterion value (e.g., 6 dB). Accordingly, when the DSL-interface containing unit 20 performs the above-mentioned interruption and the reconnection due to a signal-to-noise ratio lower than the lower limit, the DSL-interface containing unit 20 performs a negotiation by decreasing the communication speed such that the signal-to-noise ratio becomes the criterion value. On the other hand, when the DSL-interface containing unit 20 performs the above-mentioned interruption and the reconnection due to a signal-to-noise ratio higher than the upper limit, the DSL-interface containing unit 20 performs a negotiation by increasing the communication speed such that the signal-to-noise ratio reduces to the criterion value.

Additionally, the target SNR setting unit 26 sets the upper limit and the lower limit so as to obtain a hysteresis characteristic. This enables a stable operation even when the current signal-to-noise ratio frequently fluctuates.

It is noted that the duration monitoring unit 30 and the communications controlling unit 34 form a controlling unit.

FIG.3 and FIG.4 are schematic diagrams of operations of a line-quality monitoring function of the DSL communication device according to the present invention. In FIG.3, in step S10, the line-quality monitoring unit 22 monitors the signal-to-noise ratio (SNR) representing a communication quality of the DSL from which the DSL-interface containing unit 20 is currently receiving data. In step S12, the SNR comparing unit 24 reads the signal-to-noise ratio.

On the other hand, in step S14, the operator 32 sets an upper limit and a lower limit of a signal-to-noise ratio in the target SNR setting unit 26. In step S16, the SNR comparing unit 24



reads the upper limit and the lower limit. In step S18, the SNR comparing unit 24 compares the current signal-to-noise ratio with the set values (the upper limit and the lower limit), and outputs a result of the comparison.

In FIG.4, the duration monitoring unit 30 continually reads the comparison result output from the SNR comparing unit 24. In step S20, the operator 32 sets a reference time in the duration reference time setting unit 28. In step S22, the duration monitoring unit 30 reads the reference time.

In step S24, the duration monitoring unit 30 monitors a duration during which the current signal-to-noise ratio is outside of a range defined by the upper limit and the lower limit. When the duration surpasses the reference time, the duration monitoring unit 30 supplies a result of the monitoring to the communications controlling unit 34. In step S26, the communications controlling unit 34 receives this monitoring result, and performs a control of a communication speed improvement with respect to the DSL-interface containing unit 20. Under this control, the DSL-interface containing unit 20 interrupts the current communication once, and thereafter, the DSL-interface containing unit 20 reconnects to the DSL-interface containing unit 20 on the other end of the 2-wire telephone line 14, and establishes a negotiation by performing a handshake and an initialization such that the signal-to-noise ratio becomes the criterion value. Then, the DSL-interface containing unit 20 communicates with the DSL-interface containing unit 20 on the other end of the 2-wire telephone line 14.

As described above, the present invention can be realized by utilizing a signal-to-noise ratio monitored at a receiving side by a DSL device adopting an xDSL communications technology, and also

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by utilizing a negotiation function performed at the start of a communication. Further, all of a line quality monitoring function, a duration monitoring function of fluctuations of a line quality, and a communication control function can be realized by software (firmware) without necessarily entailing hardware, which can be operated solely by a DSL communication device at a center or user side. This overcomes a problem in interconnection between DSL devices having different functions, and costs involved therewith.

Besides, although the duration of the current signal-to-noise ratio exceeding the upper limit and the duration of the current signal-to-noise ratio falling below the lower limit are compared to the same reference time in the above-described embodiment, the above-mentioned durations may be compared to first and second reference times, respectively, differently set in the duration reference time setting unit 28. This provides a time hysteresis.

The present invention is not limited to the specifically disclosed embodiments, and variations and modifications may be made without departing from the scope of the present invention.

The present application is based on Japanese priority application No. 2001-260378 filed on August 29, 2001, the entire contents of which are hereby incorporated by reference.

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